Sampling and Analysis Plan
Quality Assurance Project Plan
Washington State Urban Background Soil Concentration Study

Prepared for
Washington State
Department of Ecology

March 18, 2011
17330-29

HARTCROWSER

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Prepared by
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Washington State Urban Background Soil Concentration Study

Sampling and Analysis Plan

Review Form

Signature: _____ Date: _____
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Signature: _____ Date: _____
Bill Kammin, Washington State Department of Ecology Quality Assurance Officer

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Signature: _____ Date: 3/17/2011__
Roger McGinnis, Ph.D., Hart Crowser Project Manager

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SAMPLING AND ANALYSIS PLAN/
QUALITY ASSURANCE PROJECT PLAN
WASHINGTON STATE URBAN BACKGROUND SOIL CONCENTRATION STUDY

1.0 INTRODUCTION

This combined Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP) describes the sampling locations, field sampling procedures, laboratory analytical methods, data evaluation procedures, and quality control criteria to support the Washington State Department of Ecology (Ecology) urban background soil concentration study.

In 1999, Ecology performed a dioxins/furan soil survey for 30 urban, forested, and open area sampling locations across the state (Ecology 1999). Samples were collected from a depth of 0 to 5 cm (0 to 2 inches). In November and December 2010, Ecology collected samples as part of a state-wide rural background study for dioxin analysis from 35 state parks across the state. For the rural study, samples were collected from a depth of 0 to 3 inches. Data are currently being evaluated and the report will be published in Spring 2011.

The purpose of this investigation is to collect sufficient data from various Seattle neighborhoods to determine the range and magnitude of concentrations and total toxic equivalents (TEQs) of dioxins and furans that represent Seattle urban area background concentrations as defined in the MTCA rule.

Urban soil will be collected and analyzed for dioxin/furans in six Seattle neighborhoods: South Park, Georgetown, West Seattle, Ballard, Capitol Hill, and Ravenna. The neighborhoods to be sampled are shown on Figure 1.

Twenty shallow soil samples (0 to 3 inch depth) will be collected from each neighborhood for a total of 120 samples. To ensure samples are spread throughout each neighborhood, each neighborhood will be divided into four (ten in South Park only) quadrants containing an approximately equal number of properties per quadrant within each neighborhood (i.e., within each neighborhood the number of properties per quadrant will be approximately the same; however, the number of properties per quadrant among neighborhoods will differ because neighborhoods differ in size). An equal number of samples will be collected from randomly selected locations within each quadrant. Each sample will be a composite of five individual samples collected from City of Seattle right-of-way land in front of a single property.

Samples will be analyzed for the following parameters:

- 2,3,7,8-substituted chlorinated dioxins and furans
- Total Organic Carbon (TOC)
- Grain size
- Total solids

All analytical sample results will be reviewed for quality assurance and data validations. Sampling results and laboratory data will be compiled and evaluated. Data will be evaluated using EPA's ProUCL software to calculate summary statistics and urban soil mean and 90th percentile chemical concentrations according to the MTCA approach to calculation of background.

Sampling locations, procedures, analytical methods, and evaluation of results are discussed in subsequent sections of this SAP/QAPP.

2.0 PROJECT TEAM AND RESPONSIBILITIES

Key staff members and their project functions are listed below.

- Charles San Juan, Ecology Project Manager
- Mike Ehlebracht, LHG, Program Manager, Health and Safety Manager
- Roger McGinnis, PhD, Project Manager, Senior Chemist
- Anne Conrad, MS, Project Chemist
- Beth Schmoyer, City of Seattle oversight and coordination

Chemical analysis will be performed by Columbia Analytical Services (CAS) located in Kelso, Washington. Dioxin analysis will be performed by the CAS Houston, Texas laboratory. CAS is accredited by the State of Washington. The CAS project manager will be Mike Shelton.

Data validation will be performed by EcoChem of Seattle, Washington.

3.0 SAMPLING LOCATIONS

Urban soil will be collected and analyzed for dioxin/furans in the following six Seattle neighborhoods shown on Figure 1:

- South Park
- Georgetown
- West Seattle
- Capitol Hill
- Ballard
- Ravenna

Most neighborhoods will be divided into four quadrants with approximately equal numbers of single-family residential properties in each quadrant. South Park will have 10 quadrants. Equal numbers of residences (plus or minus a few) in each quadrant are necessary to ensure an equal probability of each parcel being sampled in each neighborhood. Quadrants for each neighborhood are presented on Figures 2 through 7.

Samples will be collected from City of Seattle rights-of-way. In most instances, this property includes soil between a sidewalk and the curb, termed planting strips.

Twenty shallow soil samples (0 to 3 inch depth) will be collected from each neighborhood for a total of 120 samples. Five sample locations will be randomly selected from each of the four quadrants established for each neighborhood (ten areas with two samples each in South Park).

For each neighborhood, the presence of suitable sampling areas (i.e., right-of-way properties that meet the exclusion criteria described in Section 4.2) will be assessed using web-based tools by Ecology and a drive-by survey will be conducted by the City. There should be at least 10 acceptable right-of-way properties in each study area based on the drive-by. A minimum of 10 will ensure that when final locations are selected a sufficient number will be available in case exclusion criteria (when applied by the field crew) are not easily met. If ten properties cannot be identified, the quadrants will be redefined.

A randomized list of all single-family residential properties constructed prior to 1975 within each neighborhood sampling area will be generated. Addresses for the first ten properties on the list will be printed on paper and cut to the size of a business card. Seattle personnel will personally review each of these properties for acceptability by driving by the property and assessing if it meets the exclusion criteria. Properties not meeting exclusion criteria will be removed from further consideration for sampling (i.e., the printed address will be destroyed).

Sampling will be conducted by the Ecology contractor and City of Seattle staff will accompany the sampling teams. During sampling, the field leader will

randomly select five (or two for South Park) addresses by blindly drawing the address slips of paper from an envelope. The field crew will drive to the first selected property and determine if it meets the exclusion criteria. If it does, it will be sampled. If it does not, then the field leader will select another address from the envelope. This process will be repeated until the required number of properties has been sampled in each quadrant. The address pulled from the envelope will be discarded in a second envelop and both envelopes will by collected by the City representative at the end of the sampling day.

Sufficient soil will be sampled to ensure the City can take a split sample. The City will supply sampling containers for the splits. Since sieving and multi-incremental sample (MIS) preparation will be performed by the laboratory before sample extraction to minimize sample heterogeneity and particle size effects, split sample results may not be comparable unless the City's laboratory performs similar sample preparation procedures or sample splitting is performed at CAS laboratory.

During sampling, no information will be recorded that could identify the sampled parcel. Area photos will not be taken and parcel addresses, descriptions, and GPS coordinates will not be recorded. Sample jars will be labeled with area and quadrant only.

During reporting, dioxin data will be reported by quadrant, and the quadrants will be identified on maps.

4.0 FIELD SAMPLING METHODS

The concentration of air-deposited contaminants in surface soils can vary greatly over very short distances. This phenomenon is believed to be a result of small-scale differences in deposition and soil characteristics and—most importantly—of natural and manmade soil-disturbing actions, which typically occur in a patchy fashion. The resources available for this study preclude collecting and independently testing multiple samples from individual properties. A single sample might not represent concentrations throughout a property. A decision was made to collect small-scale composite samples in this study, which will better represent typical values at the compositing spatial scale.

Uppermost soil intervals are most representative of potential human contact with and exposure to soil contaminants and, absent physical disturbance of the soils, these intervals typically contain the highest concentrations of air-deposited chemicals at a sampling location. Available information indicates that the uppermost sampling interval should be limited in depth to avoid diluting higher

near-surface concentrations with the lower concentrations that are present at greater depths. Therefore, a depth interval of 0 to 3 inches was selected.

4.1 Sample Location

After selecting a sampling point at a right-of-way property, five subsample locations will be established and marked on the ground using pin flags. The default design will be to collect five subsamples from equidistant locations at each address. Samples should be collected along the center of the right of way, parallel to the street. The first and fifth subsample locations should be three feet from the ends of the property right of way. This layout may be modified by field personnel using their best judgment on collecting representative samples if obstacles or excluded ground surfaces occur.

After marking subsample locations with pin flags, a photograph of the immediate sampling location will be taken and recorded in the field log book or sampling form. Any other pertinent information will also be recorded on the field sampling form.

4.2 Sample Exclusion Criteria

Surface soil samples should be collected from the City of Seattle's right-of-way area. The overall appearance of the right-of-way area sampled must be similar to the appearance of the adjacent residential structure. For example, if the yard of the residence is a green, well-maintained grassy area and the right-of-way area is also a green, well-maintained grassy area, then this is a suitable location for surface soil sampling. A strong preference should be given to areas where the right of way is isolated from the street by a curb, to reduce the possibility that the right of way is influenced by street runoff or vehicle parking or passage. It is recognized that are few curbs in many subareas of the South Park neighborhood. Therefore, more than 10 to 20 randomly listed properties may be required to locate those with curbed right-of-ways. Field crews must make a visual assessment of similarities and differences between the residential yard and the adjacent right of way before sampling. The presence of any of the following conditions that differentiate the yard and right of way should be sufficient to categorize the right of way as unrepresentative of the yard:

- The right-of-way area has been paved or bricked over;
- The right-of-way area is less than three feet wide;
- The ground within the right-of-way area has been disturbed (e.g., footprints, tire tracks, recent digging);

- The right-of-way area has been landscaped (e.g., the grade raised for use as a planter or garden);

- The right-of-way area contains dissimilar planting from the yard of the residence (e.g., grass in yard is green and grass in right-of-way area is brown or yellow);

- Tree cover is distinctly different in the yard and right of way (e.g., tree canopy covers the majority of the right-of-way area but not the yard);

- Vehicles have been parked on the right-of-way area;

- The right-of-way area is inundated with water or is below the grade of the yard, sidewalk, and road so that it could collect runoff;

- Staining or areas of dead vegetation are observed; or

- Unusual quantities of litter, other garbage, or derelict cars are present within the right-of-way area.

Field staff are expected to apply judgment in the application of these criteria, and in the identification of other conditions that may differentiate yards and rights of way.

Note: for the South Park study area, decisions about exclusion criteria for parked cars will be made on case-by-case basis. It may be necessary to sample areas where cars have been parked. Field teams will use best professional judgment and take care not to sample in areas where staining or dead vegetation is present. In South Park, many of the streets do not have curbs/gutters. Therefore, more than 10 to 20 randomly listed properties may be required to locate those with curbed right of ways. If the target area does not have a curb then the field teams will use their professional judgment for uncurbed sampling locations and will consult with both the City and Ecology as needed.

If charcoal, landscaping materials, or other foreign materials are observed in any of the subsamples, the sampling location will be abandoned and a new sample location will be selected.

4.3 Surface Soil Sample Collection

A list of equipment supplies for the field effort is included as Appendix A.

Soil sample collection will be performed in a consistent manner by field personnel at all sampling locations to ensure data are representative. Samples collected should be representative of the targeted 0- to 3-inch-depth profile. Care should be taken to collect all size fractions and avoid loss of fine material. Excess soil will be collected so that the City of Seattle receives a 16-ounce split sample and so material can be archived for future additional analysis.

Site conditions within 2 feet of each subsampled location will be recorded in field books and on field sampling forms. Plastic sheeting will be used to stockpile groundcover and excavated soil. Materials placed on plastic sheeting will be used to backfill and re-cover sampling locations.

Note that because cigarette smoke is a potential source of PAHs and dioxins/furans, there shall be absolutely no smoking at any time during the sample collection process. Exhaust from vehicles and electrical generators can also be a source of PAHs and dioxins/furans and, therefore, sample collection shall be performed away from running vehicles or generators and any other combustion sources, to the extent possible.

After the individual sampling point locations are determined, the individual sampling points will be cleared of surface organic materials.

4.3.1 Remove Groundcover

Groundcover may consist of grass, other vegetation, or rocks/pebbles. An area of approximately 8 inches by 8 inches will need to be uncovered. The actual area may vary by site depending on how rocky the soil is and how much vegetation is present. Groundcover removal procedures include:

- Remove the surface layer of grass, leaves, or twigs at each subsample point using a clean spade, shovel, or trowel. The groundcover should only be removed to the point where soil is exposed, being careful not to disturb the soil below. An effort should be made to collect soil adhering to roots by shaking or brushing it into the collection bowl.

- If the sampling point does not contain vegetation, then any rocks or pebbles can be brushed aside by the sampler(s) using a gloved hand.

4.3.2 Subsample Collection

Samples will be collected from each of the five sampling point locations from the upper 0 to 3 inches of soil using a precleaned stainless steel spoon, trowel, or other tool. Sufficient soil must be collected for both bulk grain size analysis (one

16-ounce jar) and chemical analytical tests (one 32-ounce jar), plus sufficient sample for a 16-ounce split sample for the City of Seattle. Organic matter such as roots, leaves, twigs, landscaping materials, and debris should be excluded from the sample. Rocks, pebbles, and large gravel (greater than 2 cm diameter) may be removed from the sample collected for chemical analysis but should not be removed from the sample collected for grain size.

Surface soil (0 to 3 inches) subsamples will be collected as follows:

- Put on a clean pair of nitrile gloves.
- Excavate soil to a depth of 3 inches with a clean spade, spoon, bulb planter or trowel. Use a ruler to accurately determine the depth.
- Place soil into a stainless steel bowl.
- Repeat this process at the other subsample locations collecting approximately equal volumes of soil from each of the five sampling point locations.
- Remove any large fragments of organic matter such as sticks or roots from the bowl, taking care to retain soil particles adhered to debris to the extent practical.
- Homogenize the soil in the bowl by mixing with a collection spoon and then separate the soil into four equal aliquots by drawing an "X" in the soil with the spoon.
- Place one spoonful of soil from each quarter into a clean 16-ounce sample container for grain size analysis, continuing until the container is full. Take care to ensure the soil placed in the jar is representative of the grain size and vertical distribution in the sample.
- Using a clean gloved hand, remove any large rocks or gravel from the bowl, taking care to retain soil particles adhered to debris to the extent practical.
- Again, homogenize the soil in the bowl by mixing with a collection spoon and then separate the soil into four equal aliquots by drawing an "X" in the soil with the spoon.
- Place one spoonful of soil from each quarter into two sample containers (one 16 ounce and one 32 ounce) for chemistry analysis, continuing until each container is full. Take care to ensure the soil placed in each jar is

representative of the grain size and vertical distribution in the sample. The 16 ounce jar is the City of Seattle split sample.

- Once containers are full, the rims should be wiped using a clean paper towel, and the lids tightly screwed on.

- The sample jars should be labeled with the date, time, analysis (grain size, other) and sample identification (i.e., neighborhood and quadrant number) and placed in ziplock bags.

- Place the labeled sample containers into an iced cooler.

- Remove pin flags once soil samples have been collected and return site to original state as best as possible. Potting soil may be used to fill any holes created by sample removal.

- As samples are collected, the City staff will be given their 16-ounce container of each sample as the City split.

4.3.3 Sample Sieving

The soil sample collected for chemical analysis will be sieved by the laboratory using an ASTM No. 10 (2 mm) screen, to obtain finer-grained material consistent with MTCA requirements. Additional details are provided in Section 6.0.

4.4 Equipment Decontamination Procedures

Precleaned equipment will be used for all soil sampling. All reusable or nondedicated field equipment (e.g., sampling spoons, mixing bowls, spade/shovel) will be decontaminated prior to reuse but will not be decontaminated between subsample collection at one location. Equipment will be cleaned in the following manner:

- Nitrile gloves (or equivalent) must be worn during decontamination.

- Excess soil will be removed using paper towels or by dry brushing.

- Rinse with potable water, collecting rinse water in one of the decontamination buckets.

- Wash with a spray bottle containing Liquinox™ (or equivalent nonphosphate detergent) and water and clean with the stiff-bristle brush until all evidence of soil or other material has been removed.

- Rinse with deionized or distilled water three times, ensuring that all soap from the previous step has been removed.

- Place the equipment on a piece of aluminum foil to air dry.

- A trash bag should be provided for waste paper towels, aluminum foil, and used nitrile gloves.

4.5 Disposal of Investigation-Derived Waste

4.5.1 Disposal of Incidental Trash

Incidental trash generated during this investigation (including discarded nitrile gloves, aluminum foil, paper towels, and disposable equipment) will be placed in plastic trash bags and disposed of as solid waste.

4.5.2 Decontamination Water Disposal

Soap and water decontamination solution will be collected for disposal into a sanitary sewer system.

4.6 Sample Containers and Labels

Sample container requirements vary according to analyte. Precleaned sample containers will be obtained from the analytical laboratory. Sample containers shall be cleaned following the requirements described in Specifications and Guidance for Contaminant-Free Sample Containers (EPA 1992a, OSWER Directive 92.0-05a). Required sample containers, preservatives, and holding times are summarized in Table 1.

Samples will be labeled and identified according to the following convention:

"Neighborhood" – "Study Area" – "Sample ID"

Where Neighborhoods identifiers will be:

- South Park = SP
- Georgetown = GT
- Capitol Hill = CH
- West Seattle = WS
- Ballard = BA, and
- Ravenna = RA

The study area for each neighborhood will be identified by a number (1 through 4; 1 through 10 for South Park) depending upon the study area the selected parcel is located in.

Sample ID will consist of sequential letters – A for the first sample collected from a Study Area, B for the second, etc. For example, the second sample collected from Study Area 3 in West Seattle would be named "WS-3-B."

4.7 Field Documentation

Field notes will be maintained during sampling and processing operations. The following information will be included in the field notes:

- Sample name. Note that the specific sample location will not be identified;
- Names of the field sampler collecting and logging the samples;
- Weather conditions;
- Date, time, and identification of each sample, including number of jars and tests requested;
- Documentation using photographs – Photographs of the sample excavations ad immediate area only; no photos that could potentially identify the sampling address will be taken.
- Details of sample collection, including documentation that exclusion criteria were observed;
- Any deviation from the approved SAP; and
- General observations that could potentially aid in interpretation of any anomalous results.

5.0 SAMPLE HANDLING PROCEDURES

5.1 Sample Preservation and Holding Times

Samples will be preserved according to the requirements of the specific analytical methods to be employed, and all samples will be extracted and analyzed within method-specified holding times. Required sample containers, preservatives, and holding times are summarized in Table 1.

5.2 Chain of Custody and Shipping Procedures

5.2.1 Chain of Custody Procedures

Chain of custody forms will be used to document the collection, custody, and transfer of samples from their initial collection location to the laboratory, and their ultimate use and disposal. Entries for each sample will be made on the custody form after each sample is collected.

Sample custody procedures will be followed to provide a documented record that can be used to follow possession and handling of a sample from collection through analysis. A sample is considered to be in custody if it meets at least one of the following conditions:

- The sample is in someone's physical possession or view;
- The sample is secured to prevent tampering (i.e., custody seals); and/or
- The sample is locked or secured in an area restricted to authorized personnel.

A chain of custody form will be completed in the field as samples are packaged. At a minimum, the information on the custody form shall include the sample number, date and time of sample collection, sampler, analysis, and number of containers. Two copies of the custody form will be placed in the cooler before sealing for delivery to the laboratory with the respective samples. The other copy will be retained and placed in the project files after review by the Project Chemist. Custody seals will be placed on each cooler or package containing samples so the package cannot be opened without breaking the seals.

5.2.2 Sample Shipping Procedures

After sample containers have been filled, they will be packed on ice in coolers. The coolers will be transferred to CAS for chemical analysis. Chain of custody procedures will commence in the field and will track delivery of the samples to the analytical laboratories. Specific shipping procedures are as follows:

- Samples will be packaged and shipped in accordance with US Department of Transportation regulations as specified in 49 CFR 173.6 and 49 CFR 173.24;
- Individual sample containers will be packed to prevent breakage;

- The coolers will be clearly labeled with sufficient information (name of project, time and date container was sealed, person sealing the cooler, and the Hart Crowser office name and address) to enable positive identification;

- A sealed envelope containing custody forms will be enclosed in a plastic bag and taped to the inside lid of the cooler;

- Signed and dated custody seals will be placed on all coolers prior to shipping;

- Samples will either be shipped by overnight courier or will be hand delivered to the laboratory by Hart Crowser personnel; and

- Upon transfer of sample possession to the testing laboratories, the custody form will be signed by the persons transferring custody of the coolers. Upon receipt of samples at the laboratory, the shipping container custody seal will be broken and the laboratory sample-receiving custodian will compare samples to information on the chain of custody form and record the condition of the samples received.

6.0 LABORATORY METHODS

Samples submitted for chemical analysis will be sieved and subsamples for extraction and subsequent chemical analysis will be performed using a multi-incremental sampling (MIS) subsampling procedure.

Samples will be sieved using a Number 10 (2mm) sieve. If samples are too wet to sieve, they will be air dried at room temperature to remove excess moisture. Drying should only be performed if necessary. If drying is required, the entire bulk sample should be evenly spread on a tray approximately 1/2 to 1 inch in thickness. Dry at ambient room temperature only until the soil matrix is amenable to sieving. Drying at elevated temperature, i.e., "baking," is not allowed. Turning the soil on a daily basis may be necessary to facilitate drying. Sieve the entire dried sample to the <2mm fraction and subsample to collect analytical and percent moisture aliquots as described below.

After sieving, the fine fraction (less than 2 mm diameter) will be spread evenly on a clean steel tray approximately 1/2 inch in depth. The tray will be divided into 30 to 50 sections and approximately 1 g will be collected from each of the sections using a small spatula. The spatula should be scraped along the bottom of the tray to make sure that every particle size is equally represented in the subsample. For each analysis, all scoops should be placed

into a single sample jar (2 or 4 ounce as appropriate) and the entire jar should be extracted for analysis.

6.1 Analytical Methods

Samples will be analyzed according to EPA methods as described in Update III to Test Methods for Evaluating Solid Waste; Physical/Chemical Methods, SW-846 (EPA 1986) and Methods for Chemical Analysis of Water and Wastes (EPA 1983), ASTM methods, and Standard Methods as summarized below.

Soil samples will be analyzed for:

- 2,3,7,8-substituted chlorinated dioxins and furans by EPA Method 1613B
- TOC by EPA Method 9060
- Grain size by ASTM D422
- Total solids by SM 2540B or equivalent

Laboratory methods, practical quantitation limits (PQL; reporting limits) and method detection limits are presented in Table 2. The individual analytes requested for the different tests are also listed in Table 2.

7.0 QUALITY ASSURANCE AND QUALITY CONTROL

The quality of analytical data generated is assessed by the frequency and type of internal QC checks developed for analysis type. The quality of laboratory measurements will be assessed by reviewing results for analysis of method blanks, matrix spikes, duplicate samples, laboratory control samples, surrogate compound recoveries, instrument calibrations, performance evaluation samples, interference checks, etc., as specified in the analytical methods to be used. The following general procedures will be followed for all laboratory analyses:

- Laboratory blank measurements at a minimum frequency of 5 percent or one per batch of 20 samples or fewer for each matrix;

- Matrix spike (MS) analysis to assess accuracy and precision at a minimum frequency of 5 percent or one per batch of 20 samples or fewer for each matrix; and

- Laboratory control sample analysis to assess accuracy in the absence of any matrix effect at a minimum frequency of 5 percent or one per batch of 20 samples or fewer for each matrix.

- A certified reference material (CRM), if appropriate CRM is available, with each analytical batch. Acceptance criteria for the CRM results (based on the 95 percent confidence interval) must be provided by the laboratory. If results fall outside the acceptance range, the laboratory may be required to re-extract and reanalyze the associated samples.

Laboratory quality control procedures, criteria, and corrective action are summarized in Tables 4 and 5.

7.1 Data Quality Indicators

The overall quality assurance objectives for field sampling, field measurements, and laboratory analysis are to produce data of known and appropriate quality to support the Ecology background soil study. The procedures and quality control checks specified herein will be used so that known and acceptable levels of accuracy and precision are maintained for each data set. This section defines the objectives for accuracy and precision for measurement data. These goals are primarily expressed in terms of acceptance criteria for the quality control checks performed.

The quality of analytical data generated is controlled by the frequency and type of internal quality control checks developed for analysis type. Laboratory results will be evaluated by reviewing results for analysis of method blanks, matrix spikes, duplicate samples, laboratory control samples, calibrations, performance evaluation samples, interference checks, etc., as specified in the analytical methods to be used.

7.1.1 Precision

Precision is the degree of reproducibility or agreement between independent or repeated measurements. Analytical variability will be expressed as the relative percent difference (RPD) between laboratory replicates and between matrix spike and matrix spike duplicate analyses. RPD will be used to measure precision for this investigation and is defined as follows:

$$RPD = \frac{(D_1 - D_2)}{(D_1 + D_2)/2} \times 100$$

Where,

D_1 = Sample value
D_2 = Duplicate sample value

Field duplicate samples will not be collected since the project objective is to evaluate chemical concentrations (and natural variability) across neighborhoods and the entire urban area rather than at individual sampling locations. In addition, composite samples will be collected at each site and MIS subsampling procedures will be employed by the laboratory to minimize sampling variability.

7.1.2 Accuracy

Accuracy is the agreement between a measured value and its true or accepted value. While it is not possible to determine absolute accuracy for environmental samples, the analysis of standards and spiked samples provides an indirect assessment of accuracy.

Laboratory accuracy will be assessed as the percent recovery of matrix spikes, matrix spike duplicates, surrogate spiked compounds (for organic analysis), and laboratory control samples. Accuracy will be defined as the percentage recoverable from the true value and is defined as follows:

$$\%\text{Recovery} = \frac{(\text{SSR} - \text{SR})}{\text{SA}} \times 100$$

Where,

SSR = spiked sample result
SR = sample results (not applicable for surrogate recovery)
SA = amount of spike added

7.1.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Care will be taken in the design of the sampling program to ensure sample locations are selected properly, sufficient numbers of samples are collected to accurately reflect conditions for each neighborhood, and samples are representative of sampling locations. A sufficient volume of sample will be collected at each sampling point to minimize bias or errors associated with sample particle size and heterogeneity.

It has been assumed that samples collected from the right of way planting strips are representative of residential soil; however, this has not been verified and will not be able to be verified with the planned sampling design.

7.1.4 Completeness

Completeness is the percentage of measurements made that are judged to be valid. Completeness will be calculated separately for each analytical group, e.g., metals or PAHs. Results must also contain all quality control check analyses required to verify the precision and accuracy of results to be considered complete. Data qualified as estimated during the validation process will be considered complete. Nonvalid measurements will be results that are rejected during the validation review or samples for which no analytical results were obtained. Completeness will be calculated for each analysis using the following equation:

$$\text{Completeness} = \frac{\text{valid data points obtained}}{\text{total data points planned}} \times 100$$

The target goal for completeness is a minimum of 95 percent. Completeness will be monitored on an ongoing basis so that archived sample extracts can be reanalyzed, if required, without remobilization.

7.1.5 Comparability

Comparability is the degree to which data from separate data sets may be compared. For instance, sample data may be compared to data from background locations, to established criteria or guidance, or to data from earlier sampling events. There has been little consistency among historical studies used to estimate background chemical concentrations. For example, intervals defined as surface soil have varied often ranging from one inch to six or more inches in depth. In addition, analytical methods have not been consistent across studies.

As discussed in Section 5, sample collection will be performed in a consistent manner by field personnel at all sampling locations to ensure all data collected as part of this study are comparable. Comparability is attained by careful adherence to standardized sampling and analytical procedures, based on rigorous documentation of sample locations (including depth, time, and date). Results from this urban study will be intracomparable since identical sampling methods and depths will be used for all samples.

The use of standardized methods to collect and analyze samples, along with instruments calibrated against National Institute for Standards and Technology (NIST) and US EPA traceable standards will also ensure comparability, particularly for comparison of data collected from this study (within-study comparability).

Data will not be directly comparable to historical results from the Terminal 117 area since historical samples were collected from depths of 0 to 2 inches and 2 to 6 inches below the surface while the sample depth for this study is the top 0 to 3 inches to be consistent with the recent rural statewide background study.

7.2 Data Quality Assurance Review

EcoChem will perform an independent data quality review of the chemical analytical results provided by CAS. This report will assess the adequacy of the reported detection limits in achieving the project screening levels for soil; the precision, accuracy, representativeness, and completeness of the data; and the usability of the analytical data for project objectives. Exceedances of analytical control limits will be summarized and evaluated.

A data evaluation review will be performed on all results using QC summary sheet results provided by the laboratory for each data package. The data evaluation review is based on the Quality Control Requirements previously described and follows the format of the EPA Contract Laboratory Program Functional Guidelines for Chlorinated Dioxin/Furan Data Review (EPA 2005) modified to include specific criteria of individual analytical methods. Raw data (instrument tuning, calibrations, instrument printouts, bench sheets, and laboratory worksheets) will be available for review if any problems or discrepancies are discovered during the routine evaluation. The following is an outline of the data evaluation review format:

- Verify that sample numbers and analyses match the chain of custody request;
- Verify sample preservation and holding times;
- Verify that instrument tuning, calibration, and performance criteria were achieved;
- Verify that laboratory blanks were performed at the proper frequency and that no analytes were present in the blanks;
- Verify that laboratory duplicates, matrix spikes, surrogate compounds, and laboratory control samples were run at the proper frequency and that control limits were met; and
- Verify that required detection limits have been achieved.

Data qualifier flags, beyond any applied by the laboratory, will be added to sample results that fall outside the QC acceptance criteria. An explanation of data qualifiers to be applied during the review is provided below:

U The compound was analyzed for but was not detected. The associated numerical value is the sample reporting limit.

J The associated numerical value is an estimated quantity because QC criteria were slightly exceeded.

UJ The compound was analyzed for, but not detected. The associated numerical value is an estimated reporting limit because QC criteria were not met.

T The associated numerical value is an estimated quantity because reported concentrations were less than the practical quantitation limit (lowest calibration standard).

K Ion ratios do not meet identification criteria acceptance limits for positive identification.

R Data are not usable because of significant exceedance of QC criteria. The analyte may or may not be present; resampling and/or reanalysis are necessary for verification.

8.0 DATA ANALYSIS AND REPORTING

8.1 Laboratory Reports

The laboratory data reports will consist of complete data packages that will contain complete documentation and all raw data to allow independent data reduction and verification of analytical results from laboratory bench sheets, and instrument raw data outputs. Each laboratory data report will include the following:

- Case narrative identifying the laboratory analytical batch number, matrix and number of samples included, analyses performed and analytical methods used, and description of any problems or exceedance of QC criteria and corrective action taken. The laboratory manager or their designee must sign the narrative.

- Copy of chain of custody forms for all samples included in the analytical batch.

- Tabulated sample analytical results with units, data qualifiers, percent solids, sample weight or volume, dilution factor, laboratory batch and sample number, Hart Crowser sample number, and dates sampled, received, extracted, and analyzed all clearly specified.

- All calibration, quality control, and sample raw data including quantitation reports and other instrument output data.

- Blank summary results indicating samples associated with each blank.

- MS/MSD result summaries with calculated percent recovery and relative percent differences.

- Surrogate compound recoveries, when applicable, with percent recoveries.

- Laboratory control sample results, when applicable, with calculated percent recovery.

- Performance evaluation or certified reference material sample results, if applicable, with acceptance limits.

- Electronically formatted data deliverable (CD) results.

8.2 Data Evaluation and Analysis

Following the planned field work, sample analysis, and data quality review, statistical evaluation of the data will be accomplished. Statistical evaluation based on total dioxin toxic equivalents (TEQs) will be performed to evaluate Seattle urban background soil chemical concentrations. Statistical evaluations will be performed by TerraStat. Data from each neighborhood study area will initially be evaluated separately to determine if there are significant differences between neighborhoods.

It is anticipated that both summary and descriptive statistics will be evaluated to determine the most appropriate steps for further data analysis. Both parametric and nonparametric 90th percentile concentrations will be calculated using EPA's ProUCL statistical software or other statistical software packages. Since it is possible that a number of censored results will be obtained, additional statistics will be evaluated using non-routine statistical methods.

8.3 Hart Crowser Reports

Hart Crowser will prepare a draft report summarizing sampling procedures and laboratory testing results. The report will include a map(s) with sampling areas, tabulated analytical testing data, and laboratory analytical documentation. The report will include field notes, and photographs of soil conditions. A final report will be completed following discussions with Ecology.

9.0 SCHEDULE

A schedule of deliverables is listed below:

Task	Anticipated Completion Date
Submit Draft SAP/QAPP	February 28, 2011
Ecology Review	March 7, 2011
Submit Final SAP	March 18, 2011
Collect Samples	March 28 to April 8, 2011
Sample analytical results received	May 10, 2011
Data validation completed	May 16, 2011
Draft Report Submittal	June 1 2011
Ecology Review	June 15, 2011
Revised Report	June 21, 2011
Project Closeout	June 30,2011

10.0 REFERENCES

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EPA Method 1613, Revision B. 1994. Tetra- through Octa-Chlorinated Dioxins and Furans by Isotope Dilution HRGC/HRMS. EPA-821-B-94-005).

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EPA 2001. Guidance on Environmental Data Verification and Validation. EPA QA/G-8.

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EPA 2005. Guidance for Developing Ecological Soil Screening Levels. OSWER Directive 9285.7-55. Office of Solid Waste and Emergency Response, Washington, D.C.

EPA 2007. Pilot Survey of Levels of Poly-chlorinated Dibenzo-p-dioxins, Polychlorinated Dibenzofurans, Polychlorinated Biphenyls, and Mercury in Rural Soils of the United States. National Center for Environmental Assessment, Office of Research and Development, Washington, DC. EPA/600/R-05/048F April 2007.

EPA 2005. US EPA Contract Laboratory Program Functional Guidelines for Chlorinated Dioxin/Furan Data Review Office of Emergency and Remedial Response.

Standard Methods for the Examination of Water and Wastewater. 17th Edition, 1989.

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Table 1 - Sample Containers, Preservation, and Holding Times

Sample Type	Sample Preservation Technique	Maximum Holding Time
Grain Size[1]	Cool, <6°C	6 months
Total solids[2]	Cool, <6°C	14 days
Total organic carbon[2]	Cool, <6°C	14 days
PCDDs/PCDFs[2]	Freeze, -18°C	1 year
after extraction	Cool, <6°C	40 days
Archive Sample	Freeze, -18°C	1 year

Notes:

[1] Grain size will be collected in a 16-oz wide mouth glass jar.
[2] Soil sample for chemical analysis will be collected in one 32-oz (or larger) wide mouth glass jar, to provide sufficient volume for sieving at the laboratory.

PCDD - polychlorinated dibenzo-p-dioxin
PCDF - polychlorinated dibenzofuran

Table 2 - Recommended Methods of Sample Preparation and Analysis, Practical Quantitation Limits (PQL), and Method Detection Limits (MDL)

Parameter	Prep Method	Analysis Method	Practical Quantitation Limits[1]	Estimated Sample Detection Limits
CONVENTIONALS:				
Total Solids in %	N/A	SM 2540B	0.1% (wet weight)	
Total Organic Carbon in %	N/A	EPA 9060M	0.05	0.02
Grain Size	N/A	ASTM D422 without hydrometer	1%	
CHLORINATED DIOXIN/FURAN CONGENERS			**ng/kg (dry weight)**	
1,2,3,4,6,7,8-HpCDD	EPA 1613B	EPA 1613B	5.0	0.26
1,2,3,4,6,7,8-HpCDF	EPA 1613B	EPA 1613B	5.0	0.22
1,2,3,4,7,8,9-HpCDF	EPA 1613B	EPA 1613B	5.0	0.35
1,2,3,4,7,8-HxCDD	EPA 1613B	EPA 1613B	5.0	0.19
1,2,3,4,7,8-HxCDF	EPA 1613B	EPA 1613B	5.0	0.09
1,2,3,6,7,8-HxCDD	EPA 1613B	EPA 1613B	5.0	0.19
1,2,3,6,7,8-HxCDF	EPA 1613B	EPA 1613B	5.0	0.10
1,2,3,7,8,9-HxCDD	EPA 1613B	EPA 1613B	5.0	0.19
1,2,3,7,8,9-HxCDF	EPA 1613B	EPA 1613B	5.0	0.15
1,2,3,7,8-PeCDD	EPA 1613B	EPA 1613B	5.0	0.15
1,2,3,7,8-PeCDF	EPA 1613B	EPA 1613B	5.0	0.14
2,3,4,6,7,8-HxCDF	EPA 1613B	EPA 1613B	5.0	0.11
2,3,4,7,8-PeCDF	EPA 1613B	EPA 1613B	5.0	0.16
2,3,7,8-TCDD	EPA 1613B	EPA 1613B	1.0	0.17
2,3,7,8-TCDF	EPA 1613B	EPA 1613B	1.0	0.12
OCDD	EPA 1613B	EPA 1613B	10.0	0.59
OCDF	EPA 1613B	EPA 1613B	10.0	0.57
Total TCDDs	EPA 1613B	EPA 1613B	N/A	N/A
Total PeCDDs	EPA 1613B	EPA 1613B	N/A	N/A
Total HxCDDs	EPA 1613B	EPA 1613B	N/A	N/A
Total HpCDDs	EPA 1613B	EPA 1613B	N/A	N/A
Total TCDFs	EPA 1613B	EPA 1613B	N/A	N/A
Total PeCDFs	EPA 1613B	EPA 1613B	N/A	N/A
Total HxCDFs	EPA 1613B	EPA 1613B	N/A	N/A
Total HpCDFs	EPA 1613B	EPA 1613B	N/A	N/A

Notes:

1. Practical quantitation limits and method detection limits are taken from Columbia Analytical Services (CAS) - Houston for dioxin/furans and from CAS - Kelso for remaining analytes.

Table 3 - Quality Control Procedures for Conventionals Analysis

	Suggested Control Limits						
Analyte	**Initial Calibration**	**Continuing Calibration**	**Calibration Blanks**	**Laboratory Control Samples**	**Matrix Spikes**	**Laboratory Duplicates**	**Method Blank**
Grain size	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	20 % RSD	Not applicable
Total organic carbon	Correlation coefficient ≥0.995	90–110 % recovery	Analyte concentration ≤ PQL	80–120 % recovery	75–125 % recovery	20 % RSD	Analyte concentration ≤ PQL
Total solids	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	20 % RSD	Analyte concentration ≤ PQL

Table 4 - Quality Control Procedures for Dioxins/Furans Analysis

Quality Control Procedure	Frequency	Control Limit	Corrective Action
Instrument Quality Assurance/Quality Control			
Initial Calibration	See reference method(s) in Table 4	See reference method(s) in Table 3	Laboratory to recalibrate and reanalyze affected samples
Continuing Calibration	See reference method(s) in Table 4	See reference method(s) in Table 3	Laboratory to recalibrate if correlation coefficient or response factor does not meet method requirements
Method Quality Assurance/Quality Control			
Holding Times	Not applicable	See Table 2	Qualify data or collect fresh samples in cases of extreme holding time or temperature exceedance
Detection Limits	Annually	See Table 3	Laboratory must initiate corrective actions (which may include additional cleanup steps as well as other measures, see Table 5) and contact the QA/QC coordinator and/or project manager immediately.
Method Blanks	One per sample batch or every 20 samples, whichever is more frequent, or when there is a change in reagents	Analyte concentration < PQL	Laboratory to eliminate or greatly reduce laboratory contamination due to glassware or reagents or analytical system; reanalyze affected samples
Matrix Spikes	One per sample batch or every 20 samples, whichever is more frequent; spiked with the same analytes at the same concentration as the LCS	See reference method(s) in Table 3	Matrix interferences should be assessed and explained in case narrative accompanying the data package.
Labeled (surrogate) Compounds	Added to every organics sample as specified in analytical protocol	See reference method(s) in Table 3	Follow corrective actions specified in method.
Laboratory Control Samples (LCS), Certified or Standard Reference Material	One per analytical batch or every 20 samples, whichever is more frequent	See reference method(s) in Table 3	Laboratory to correct problem to verify the analysis can be performed in a clean matrix with acceptable precision and recovery; then reanalyze affected samples

APPENDIX A
FIELD EQUIPMENT SUPPLY LIST,
FIELD SAMPLING FORM
SAMPLE CHAIN OF CUSTODY FORM

Field Equipment/Supplies Checklist

Item	Need	Quantity	Have	Loaded in Vehicle
Forms				
SAP/QAPP				
Health and Safety Plan				
Surface Soil Sample Collection Forms				
Field Notebook				
Maps / Coordinates				
HC Chain of Custody				
Cooler Custody Seals, Address labels, FedEx				
Sample Labels				
Packing Materials				
Large Trash Bags				
Large Ziploc Bags (1 gallon / 2 gallon)				
Medium Ziploc Bags (quart)				
Ice / Ice bags				
Scissors				
Clear tape/ strapping tape/ duct tape				
Coolers				
Sampling Containers				
16-oz jars				
32-oz jars				
Large plastic bags/ buckets with lids				
Sampling Equipment				
Large Bowls (Stainless Steel)				
Large Stainless Steel Spoons				
No. 10 Sieve				
Trowels / Bulb planter				
Disposable aluminum trays				
Stakes and flags				
Plastic sheeting				
Decon Equipment				
Potable water				
Lab Grade DI water				
Liquinox				
Sprayers for DI water and Liquinox				
Buckets & Lids				
Paper Towels				
Aluminum foil				
Brushes (big and small)				
Recording/Miscellaneous Equipment				
Camera				
GPS				
Compass				
Field Phone				
Grass Clippers / Pruners				
Shovel/Spade				
75 ft. Tape Measure / small ruler				
PPE				
Raingear				
Field gear, including boots, coat				
Nitrile Gloves				
Heavy gloves / leather gloves				
First Aid Kit				
Miscellaneous				
Clipboards				
Sharpies (big and small), pencils, pens				
Tools (calculator, spare batteries, chargers)				

Surface Soil Sample Collection Form

Sample No. _____ Collected by _____

Job _____ Date _____

Job No. _____ Latitude N/A

Location _____ Longitude N/A

Composite Sample ☐ Yes ☐ No

Photograph ☐

Sample Description (moisture, color, minor, MAJOR CONSTITUENT, NON-SOIL SUBSTANCES)

_____

_____

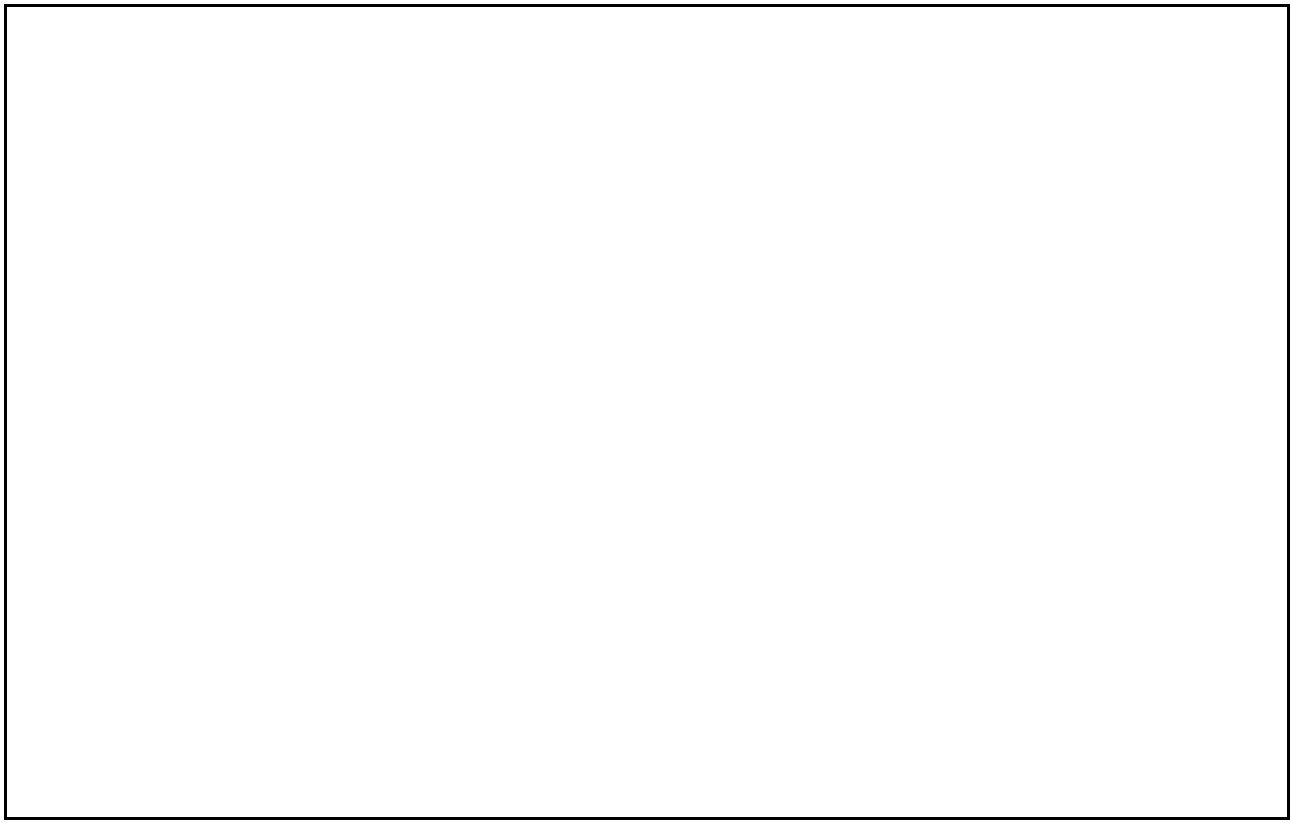
_____

Remarks _____

_____

_____

Sample Location



Sample Custody Record

Samples Shipped to: _____

HARTCROWSER

Hart Crowser, Inc.
1910 Fairview Avenue East
Seattle, Washington 98102-3699
Phone: 206-324-9530 FAX: 206-328-5581

JOB _____ LAB NUMBER _____

PROJECT NAME _____

HART CROWSER CONTACT _____

_____

SAMPLED BY:

REQUESTED ANALYSIS

NO. OF CONTAINERS

OBSERVATIONS/COMMENTS/
COMPOSITING INSTRUCTIONS

LAB NO.	SAMPLE ID	DESCRIPTION	DATE	TIME	MATRIX

RELINQUISHED BY	DATE	RECEIVED BY	DATE
SIGNATURE	TIME	SIGNATURE	TIME
PRINT NAME		PRINT NAME	
COMPANY		COMPANY	

RELINQUISHED BY	DATE	RECEIVED BY	DATE
SIGNATURE	TIME	SIGNATURE	TIME
PRINT NAME		PRINT NAME	
COMPANY		COMPANY	

SPECIAL SHIPMENT HANDLING OR
STORAGE REQUIREMENTS:

COOLER NO.: STORAGE LOCATION:

See Lab Work Order No. _____
for Other Contract Requirements

TOTAL NUMBER OF CONTAINERS

SAMPLE RECEIPT INFORMATION
CUSTODY SEALS:
☐YES ☐NO ☐N/A
GOOD CONDITION
☐YES ☐NO
TEMPERATURE _____
SHIPMENT METHOD: ☐HAND
☐COURIER ☐OVERNIGHT

TURNAROUND TIME:

☐ 24 HOURS ☐ 1 WEEK
☐ 48 HOURS ☐ STANDARD
☐ 72 HOURS OTHER _____

White and Yellow Copies to Lab Pink to Project Manager Lab to Return White Copy to Hart Crowser Gold to Sample Custodian